

**MORPHOLOGY AND MATING CONFIGURATION OF GENITALIA
OF THE ORIENTAL COCKROACH,
BLATTA ORIENTALIS L. (BLATTODEA: BLATTIDAE)**

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Abstract.—Male and female genitalia of the oriental cockroach, *Blatta orientalis* L., are redescribed and illustrated. New terms are assigned to lobes of the left and right phallobes of the male genitalia. Aspects of the mating behavior are presented, including the function of the titillator in initiating copulation. The configurational arrangement of the genitalia during copulation is described and illustrated, including the functions and positions of the three phallobes of the male genitalia with the valvulae of the female ovipositor. The five modified lobes of the male left phallobere and the scoop-like ventral phallobere function mainly to stabilize the female valvulae on each side, while the serrata of the right phallobere performs to separate the paired first valvulae from the center. This spreading configuration provides for the successful transfer of spermatophore.

Key Words: *Blatta orientalis*, morphology, genitalia, copulation

The oriental cockroach, *Blatta orientalis* L., is native to North Africa and now is distributed throughout the temperate regions of the world (Cornwell 1968, Cochran 1982, Woo 1987). It is the dominant cockroach pest species in Great Britain (Ragge 1965, Cornwell 1968). Mampe (1972) and Piper and Frankie (1978) reported it to be a seasonal household pest in portions of the northwestern, midwestern, and southern United States. The pest status of the oriental cockroach has been documented by Thoms and Robinson (1986, 1987).

Snodgrass (1933) provided a comprehensive description of the female genitalia and related musculature of *B. orientalis*. Snodgrass (1937) also described and illustrated the male genitalia of this species and presented a hypothetical plan for the phylogenetic development of the male genitalia and corresponding phallic musculature.

Marks and Lawson (1962) and McKittrick (1964) compared and illustrated ovipositors of several cockroach species. They considered the structure of the ovipositor of the oriental cockroach very similar to that of *Periplaneta americana* (L.) and other *Periplaneta* species. The morphology of the genitalia of *B. orientalis* has not been re-examined since the early descriptions and interpretations by Snodgrass (1933, 1937) and McKittrick (1964). This study provides an overall revision of the female and male genitalia and describes the mating behavior of the oriental cockroach. The configurational arrangement of the genital structure during copulation are also described and illustrated.

MATERIALS AND METHODS

Adult cockroaches were obtained from field and laboratory colonies. Genitalia of

male and female adults were examined and illustrated using an optical dissecting microscope and ocular grid. Specimens were preserved in 70% ethanol and treated with 10% aqueous potassium hydroxide (KOH) for about 24 hours at room temperature before examination and illustration. The genitalia were preserved in 70% ethanol with a few drops of glycerine for further examination and photography.

The terms and abbreviations used in this study to describe the male and female genitalia of *B. orientalis* were adopted from those used by Snodgrass (1933, 1937) and McKittrick (1964). New terms were assigned to some structures of the male genitalia.

For the study of the configurational arrangement of genitalia during copulation, male and female adults were separated soon after the final molt and kept segregated for 7 days. Mating behavior was observed and recorded when the male and female were placed together. After coupled for 20–30 minutes, the male and female were anesthetized with carbon dioxide, then killed with ethyl acetate. The configuration of the male and female genitalia during copulation was determined by dissecting the genital segments of 23 pairs of freshly killed specimens or those preserved in 10% KOH for 24 hours.

RESULTS AND DISCUSSION

Female genitalia.—The reduced eighth and ninth abdominal segments, or the genital segments, bear appendages that form the ovipositor of the female. The seventh abdominal sternum (SVII) is expanded and prolonged posteriorly to form two large, valve-like lobes (SVIIL) that conceal the ovipositor. Dorsal to the SVIIL, the paired clefts are the tenth tergum (TX). The cerci lie beneath the basal corners of the tenth tergum. Beneath the TX at the posterior end of the abdomen are a pair of sclerotized paraprocts (PAPT). These may be remnants of the eleventh abdominal segment. The

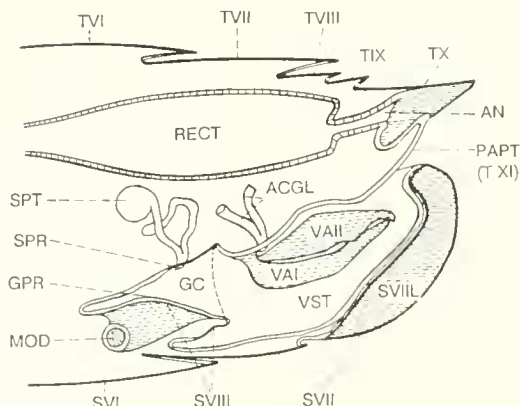


Fig. 1. Diagrammatic median view of female *Blatta orientalis* genital segment. ACGL, accessory gland; AN, anus; GC, genital chamber; GPR, gonopore; MOD, median oviduct; PAPT, paraproct (T XI); RECT, rectum; SPR, spermathecal pore; SPT, spermatheca; SVI, sixth sternum; SVII, seventh sternum; SVIIL, eighth sternum; SVIIL, lobe of seventh sternum; TVI, sixth tergum; TVII, seventh tergum; TVIII, eighth tergum; TIX, ninth tergum; TX, tenth tergum; VAI, first valvula; VAI, second valvula; VST, vestibulum. (Modified after Snodgrass 1933).

anus lies centrally in the membrane between the pair of paraprocts and the tenth tergum (Fig. 1).

There are two internal chambers, the vestibulum (VST) and the genital chamber (GC), which are formed by the modified SVII, SVIIL, SIX, SX, and TIX. The ovipositor lies in the vestibulum, with the seventh sternum as the floor of the chamber. Anterior to vestibulum is the smaller genital chamber, with the invaginated eighth sternum as its floor. The median oviduct (MOD) empties into the floor of the genital chamber by way of the gonopore (GPR). The spermatheca (SPT) possesses a pore which empties into the roof of the genital chamber. The accessory glands (ACGL) open on the roof of the vestibulum between the second pair of valvifers (VLFII) near their bases (Figs. 1, 2).

The roof of the genital chamber possesses a pair of large, lateral sclerites or basivalvulae (BSV) and a median sclerite, or spermathecal plate (SPPL) (Fig. 2). These

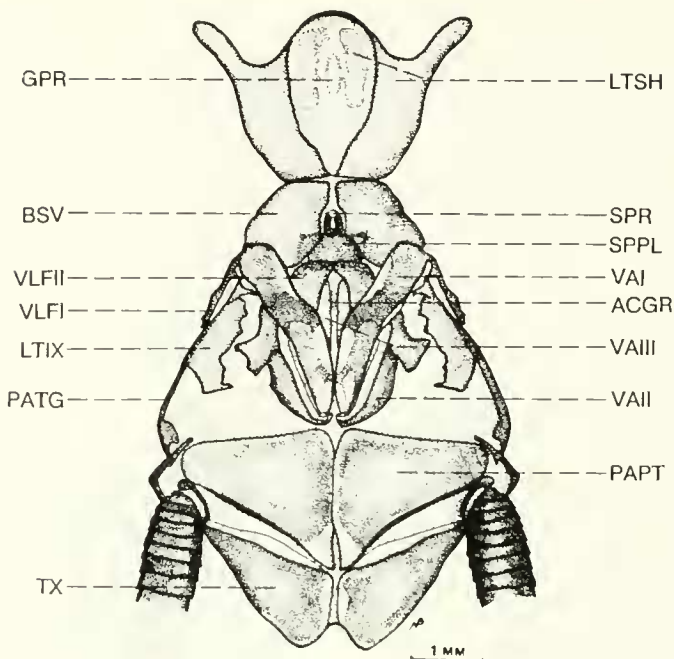


Fig. 2. Female genitalia of *B. orientalis* (ventral view). ACGR, accessory gland pore; BSV, basivalvula (SVIII); GPR, gonopore; LTIX, ninth laterosternite (SIX); LTSH, laterosternal shelf (SVIII); PAPT, paraproct (T XI); PATG, paratergite (TIX); SPR, spermathecal pore; SPPL, spermathecal plate; TX, tenth tergum; VAI, first valvula; VAI, second valvula; VAI, third valvula; VLF, first valvifer; VLFII, second valvifer.

sclerites may represent the secondary sclerotizations between the eighth and ninth segments. The floor of the genital chamber possesses two pairs of sclerites, or the laterosternal shelves (LTSH), which are derived from the eighth sternum. The gonopore lies in the membrane between the laterosternal shelves.

The roof of the vestibulum, consisting of the fused sterna of the ninth and tenth abdominal segments, supports the base of the ovipositor. The slender sclerite, or paratergite (PATG), on the roof edge of the vestibulum is derived from the ninth tergum. The irregular sclerites, the ninth laterosternites (LTIX), on the roof of the vestibulum, with the anterior ends fused to the first valvifers (VLF), are the sternites of the ninth segment.

The ovipositor has two pairs of valvifers and three pairs of valvulae. The sclerotized first pair of valvulae (VAI) of the ovipositor are widely divergent at their bases, fused to

the first pair of valvifers which may be derived from the eighth segment. The sclerotized second pair of valvulae (VAII) arise laterally from the fused, highly sclerotized second pair of valvifers. The pair of third valvulae (VAIII) are largely membranous and arise from the second valvifers, mesad of the second valvulae and beneath the first valvulae (Fig. 2).

Male genitalia.—The ninth abdominal segment, or the genital segment, bears appendages that form the genitalia of the male (Fig. 3). The bilobed tenth tergum (TX) forms the roof of the male genital chamber. The ninth sternum (SIX) bears a pair of small styli (STY), which may represent the remnants of the male gonopods. The paired paraprocts (PAPT) lie beneath the tenth tergal plate. The anus is situated in the membrane between the tenth tergum and the paraprocts.

The external genitalia of the male consist of genital lobes or phallomeres (PHM) as-

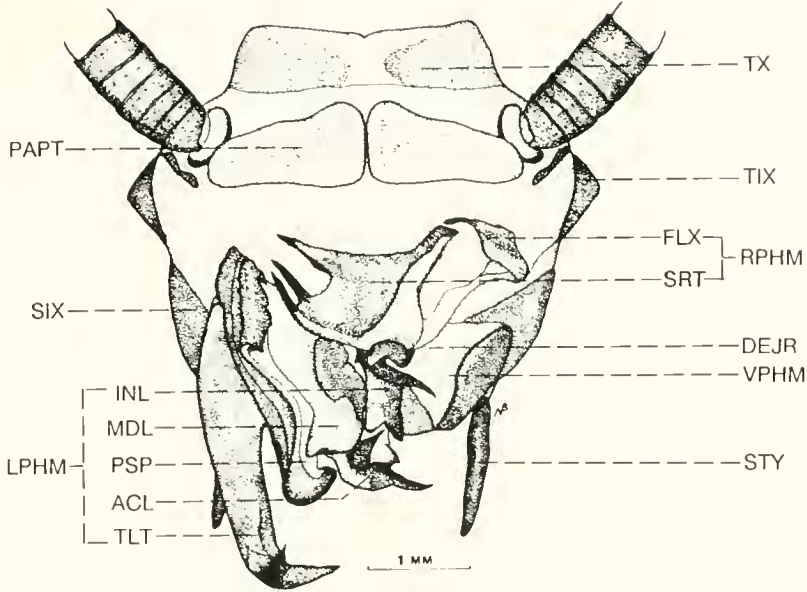


Fig. 3. Male genitalia of *B. orientalis* (dorsal view). ACL, acutolobus; DEJR, ejaculatory duct pore; FLX, falax; INL, inner lobe; LPHM, left phallomere; MDL, middle lobe; PAPT, paraproct; PSP, pseudopenis; RPHM, right phallomere; SIX, ninth sternum; SRT, serrata; STY, stylus; TIX, ninth tergum; TLT, titillator; TX, tenth tergum; VPHM, ventral phallomere.

sociated with the genital pore. Phallomeres consist of three major parts: the left, right, and ventral phallomere.

The right phallomere (RPHM) has two sclerites, the serrata (SRT) and falax (FLX), which lie on the center of the genital chamber towards the right. The serrata of the right phallomere, which lies in the center of the genital chamber, bears a fork-like sclerotized structure with two sharp processes on the left and a highly sclerotized hook-like structure on the posterior right. Snodgrass (1937) considered the serrata to be composed of three sclerites. The “right lobule” is membranous in nature. Since there are no sutures and sulci present in the serrata, there is no evidence to divide the serrata into three sclerites. The only difference is the unequal degrees of sclerotization in different portions of the serrata. The falax of the right phallomere is a simple sclerite situated laterally and joined with the right side of the serrata.

The left phallomere (LPHM) is the most complicated phallic organ of the male gen-

italia. It bears five elongated structures: the titillator (TLT), the outermost elongated and sclerotized lobe with a hook at the base of its pointed tip; the pseudopenis (PSP), mesad of the titillator with a bulbous tip; the middle lobe (MDL), next to the inner side of pseudopenis and partially sclerotized; the acutolobus (ACL), beneath the middle lobe, with a sclerotized hook and a partially sclerotized tooth-like process on its inner side; and the inner lobe (INL), the small innermost lobe with a sclerotized process on its posterior right end.

The ventral phallomere (VPHM) is a broad, scoop-like lobe projecting to the right from the posterior surface of the genital membrane. The ejaculatory duct (DEJ) empties into the floor of the genital chamber by way of the male gonopore, which is situated on a small membranous elevation on the base of the ventral phallomere.

Mating behavior and configurational arrangement of genitalia at copulation.—The mating behavior of *B. orientalis* observed in this study was very similar to previous

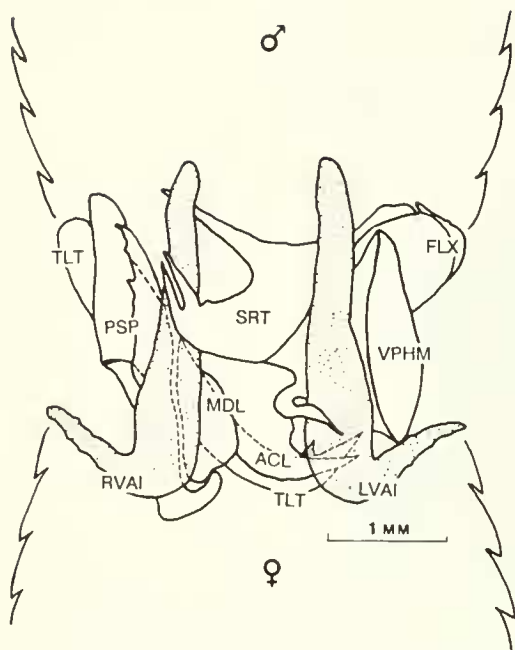


Fig. 4. Configurational arrangement of genitalia during copulation (dorsal view). ACL, acutolobus; FLX, falax; LVAI, first left valvula; MDL, middle lobe; PSP, pseudopenis; RVAI, first right valvula; SRT, serrata; TLT, titillator; VPHM, ventral phallomere.

reports by Roth and Willis (1952) and Barth (1970). The description by Barth (1970) is more similar to the observations in this study. A male is usually stimulated by contact with a female body or antennae. The aroused male typically raises his wings, and extends his abdomen, and depresses it against the substratum. Simultaneously, the titillator of the left phallomere is rhythmically protruded out of the genital chamber. The male actively searches for females and frequently attempts to back under a female from in front of her. A receptive female will move forward on the male, with her mouthparts continuously contacting his abdominal terga at the same time the male moves backwards. When the female moves to "feed" on the first abdominal tergum of the male, she spreads apart her vestibulum. Simultaneously, the male extends his abdo-

men and rapidly raises and inserts his genital segments to the vestibulum of the female. The hooked titillator of the left phallomere is the first phallic organ which fastens to the ovipositor to achieve the connection. Once the connection is established, the male swings out from underneath the female and rotates 180° to attain an opposed position. Then, the distal segments of both the sexes are tightly hooked together by way of the male genital organs inserted in the vestibulum between the ovipositor and the lobes of SVII. Copulation was observed to last 30 to 45 minutes.

During copulation the titillator and acutolobus of the left phallomere spread a great distance from the original left-side position towards the right and assist the ventral phallomere to clasp the first left-valvula (LVAI) of the ovipositor (Fig. 4). Both structures have strong, pointed tips and hooks, which help to clasp the valvulae tightly. The other lobes i.e. the inner lobe, middle lobe, and pseudopenis of the left phallomere hold the first right-valvula (RVAI) on the left-ventral side. The pseudopenis has a groove on its inner side, in which the first right-valvula is placed. The ventral phallomere grips the first left-valvula on its groove, which is formed by means of folding its distal perimeter upwards. The forks of the serrata grip the first right-valvula from the inner side towards outside, which hold the valvula along with the three lobes of the left phallomere. The hook of the serrata grips the first left-valvula from the inner side towards the outside. It is associated with the ventral phallomere, the titillator, and acutolobus. The serrata of the right phallomere keeps the first pair of valvulae open from the center, so that the other two pairs of valvulae and the genital chamber are exposed. The male gonopore, with associated membrane on the base of the ventral phallomere, projects into the female genital chamber where the spermathecal sac and the female gonopore are located. This spreading of the valvulae provides for the successful transfer of

a spermatophore from the male ejaculatory duct onto the ventrally projecting spermathecal papilla of the female. Gupta (1947) reported a similar mating behavior and configurational arrangement of genitalia at copulation for *P. americana*. He illustrated the coupled structure of the male and female genitalia and pointed out that the titillator of the male genitalia was important in forcing open the female vestibulum (gynatrium) to allow the entry of the male genitalia. He also described the importance of the right phallomere which functioned as the main clasping organ to hold the valvulae of the female genitalia during copulation. The configurational arrangement of the genitalia of *B. orientalis* is similar to that of *P. americana* during copulation.

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